PART VIII: ROUTE SURVEYING

Route surveying pertains to the laying out of proposed corridors for transportation systems in support of the mission of the Michigan Department of Transportation. Work may include surveys of existing roadways for upgrade or locating proposed new transportation systems. Route surveys require, by their nature, the use of curves to ease the transition for vehicular movement along these roads and to increase the safety for the driving public.

8.1 Alignment

Alignment data involved three different data types: survey, legal, and construction. Definitions for each are as follows:

Survey: A series of tangents and curves that define the direction of the roadway. Incremented in stations, it is used as a *baseline* for locating features, cross-sections, etc., along the roadway. This alignment may be produced from data recorded on plans, previous surveys, or other sources. In absence of any existing alignment data, a "best fit" alignment may be developed based on the physical location of the roadway. When re-establishing a survey alignment, it is the surveyor's responsibility to gather and evaluate all the evidence necessary to determine the original location of the line.

Legal: The alignment that is used to define actual ROW location based on property descriptions, conveyances, etc. Often, this line is used as part of these descriptions. A legal alignment survey is absolutely necessary when the purchase of additional ROW is required. There may be several "legal" alignments from which different parcels have been purchased. Considerable research may be required.

Establishing legal alignment is considered boundary determination since the right-of-way is often defined by, and described from, the **legal** centerline. Right-of-way plans, previous construction plans, existing monumentation including PLSS corners, and other recorded and physical evidence are to be used to determine the proper location of the legal centerline. The physical center of the existing road is evidence but does not necessarily define the legal centerline.

Construction: The alignment (horizontal and vertical) developed for the purpose of constructing a roadway. If property is purchased, MDOT policy is to describe the conveyance from the construction centerline, potentially creating another "legal" alignment. When re-establishing a construction alignment it is the surveyor's responsibility to gather and evaluate all the evidence necessary to determine the original location of the line.

The reconstruction of alignment can not be precisely defined within a single set of guidelines because the scope of work performed by MDOT through the years has changed. There are two basic criteria that must be followed. First, research is necessary to determine what information exist and the type of alignment described by that information. Second, the scope of survey may indicate whether points need to be located in the highway, or offset. The scope of survey will also outline the tasks required to complete the project.

It is important to understand that this is a property survey and that appropriate research needs to be performed. The type of records that may need to be consulted include:

- Right-of-Way books. While these are not legal documents, they often do provide a good picture of the scope of the project. These books are not updated nor are they checked by the surveyor therefore they need to be appropriately weighted in the evaluation.

- As-Built plans. These plans show the final location of the roadway although they may be difficult to locate, particularly on older projects.

- Construction plans. These plans will depict the location of the roadway in relation to the surveyed monuments used to stake out the project. Not only should the initial plans be consulted but also those records of subsequent projects over the site that have occurred since the initial construction. These newer construction plans may shed important light on a particular alignment.

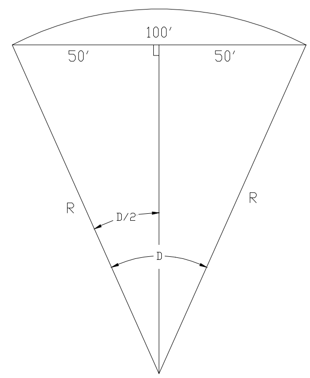
- Property and control notes from MDOT archives. These notes will identify the government corners and alignment points used by the surveyors on particular projects.

The MDOT Design Survey Office will help the surveyor gain access to the necessary MDOT records. After the research has been completed and field data collected, the surveyor will try to resolve the ambiguities that may exist in the record. In all cases, the survey consultant manager will need to be consulted during this evaluation period.

8.1.1 Existing

Exiting roadway data can be obtained by proper research. This includes researching original and subsequent plans pertaining to that particular roadway. Field verification needs to also be performed by locating evidence within the field. When the existing evidence is not consistent with the plans on file then the surveyor will note the deviation.

Figure 8.1
Chord definition for determination of radius.



When no plans exist or when the field conditions are inconsistent with the plans, the surveyor will retrace the alignment as it exists by locating the alignment. When curves exist, the surveyor will identify the different curve elements, including the PC, PI and PT stations. From this information, the existing curve data can be derived. This includes the central angle (Δ) as well as the radius, external, and tangent distances.

When a state trunk line abuts or crosses a railroad, the ROW of the railroad needs to be identified and established. Much of this railroad data may be unavailable to the surveyor. Therefore, it may be necessary to re-establish that alignment in the field. One item of importance rests with curve data. Railroad engineers and surveyors used a flat curve in their design process. They also used a different approach to determining the radius. This is based on a definition that the radius is related to the angle that subtends 100' of chord as shown in figure 8.1

If the degree of curve is given then the radius, which may be unknown, is found using:

$$R = \frac{50'}{\sin\left(\frac{D_C}{2}\right)}$$

where: R is the radius of the curve,

D_C is the degree of curve

Example: If the degree of curve was given as 5º, the radius for this curve is

$$R = \frac{50'}{\sin\left(\frac{D_C}{2}\right)} = \frac{50'}{\sin\left(\frac{5}{2}\right)} = 1{,}146.28'$$

This value can then be easily converted to metric distance by multiplying this factor by 0.3048 m/ft. The radius is then 349.39 m.

Arc definition of the degree of curve is based on an angle that subtends 100' of arc. Here, the relationship is based upon a proportion of the circle. Hence,

$$\frac{360^o}{2\pi R} = \frac{D_A}{100'}$$

from which,

$$D = \frac{360^o}{2\pi R}\left(100'\right) = \frac{5729.578}{R}$$

or

$$R = \left(\frac{360^o}{2\pi}\right)\left(\frac{100'}{D}\right) = \frac{5729.578}{D}$$

The radius from the previous example is shown to be

$$R = \frac{5729.578}{5^o} = 1{,}145.92'$$

8.1.2 Proposed

Each tangent must have at least two control points, found or set, along the alignment. The points shall be intervisible and not more than one kilometer apart. Thus, for a tangent between two curves of 3.5 kilometers on flat terrain there will be one control point at each end of the tangent (at the respective PC and PT on the curves) with three additional points in between. It is also permissible to set the points at an offset distance so that it will not lie within the road surface. If an offset is employed, witnesses shall include the offset distance and the project surveyor shall certify that the line is a true parallel offset. These offset points are considered as intermediate control. The project surveyor shall provide a sufficient number of primary and intermediate control points to allow staking of the computed alignment without additional traversing by construction survey crews.

The alignment notes shall include coordinates and at least four witnesses for all alignment points set. Complete curve data (Δ, radius, external, tangent length, PC station, PI station, and PT station) shall be calculated for all curves. A sketch of the alignment must be part of the survey notes. The alignment with stationing marked (not necessarily leveled) shall be part of the topographic map of the project, if such map is required.

8.1.3 Standards of Accuracy

The surveyor shall make sure that new alignment angles and distances reflect the accuracy with which the underlying control was established. Generally, this means bearings should be rounded to the nearest second and distances defined to the nearest 0.01 foot.

8.1.4 Monumentation

Monumentation for alignment survey points located in the hard surface road shall be a 18 inch #4 or larger rebar preferably protected by a monument box with a cover. For offset points, a one foot #4 or larger rebar shall be used. In urban areas, the surveyor should call MissDig before placing rebars one foot in length. Shorter rebars may be necessary.

8.1.5 Stationing

Stationing shall be provided for all points set in the alignment survey. This includes stationing for the PC, PT, PI and for all intermediate control points. Stationing shall be in English units. English stationing shall be incremented every 100 feet, unless otherwise noted in the request for a survey. Therefore, a station of 3+56.00 represents a point 356.00 feet from the beginning point. When using metric units for stationing the kilometer is the basic unit. Thus a station of 2+045.011 represents a point 2,045.011 meters from the beginning point. Stationing shall be sequential from south to north and from west to east. A station equation to existing stationing in feet is required in order to relate the new project to historical stationing. A section corner or a PI is a good place for such a station equation.

8.2 Route Curves for Horizontal and Vertical Alignment

The insertion of curves into road design is important for the safety of the driving public. It provides a smooth transition when the roadway changes direction and also ensures that proper and safe sight distances are maintained for the speed which the road will accommodate. The change of direction can occur in both the horizontal and vertical direction.

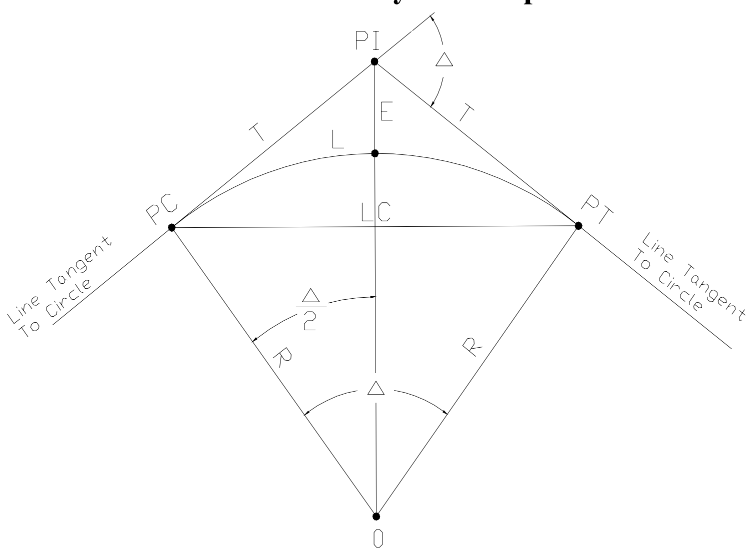
8.2.1 Horizontal

A horizontal curve is one where the change in direction occurs in the plan direction. This means that the curve will direct the road to the right or to the left.

8.2.1.1 Simple Horizontal Curves

The geometry of the simple horizontal curve is shown in figure 8.2. The tangent distances intersect the circle at the point of curve (PC) and the point of tangency (PT). Stationing along the curve goes from the PC to the PT. The PI is the point of intersection of the two tangents. The distance from the PC to the PI and from the PI to the PT is the tangent distance (T). L is the length of the curve along the arc. E is called the external distance measured from the PI to where the bisector of the central angle, Δ, intersects with the arc of the curve. LC is the long chord distance from the PC to the PT. The radius, R, is the distance from the arc to the center of the circle. The central angle is the same as the deflection angle measured at the PI from the back tangent (PC to PI) to the forward tangent (from PI to PT).

Figure 8.2
Geometry of a simple horizontal curve.



The basic relationships for the different elements of the curve are as follows. Given the radius and central angle, the tangent is found from

$$T = R \tan\left(\frac{\Delta}{2}\right)$$

The long chord from the PC to the PT is found using the following relationship.

$$LC = 2\,R\,\sin\left(\frac{\Delta}{2}\right)$$

One can compute the external distance as

$$E = R\left(\sec\frac{\Delta}{2} - 1\right) = R\left(\frac{1}{\cos\frac{\Delta}{2}} - 1\right)$$

Finally, the length of the curve is found using the next formula.

$$L = R\Delta\left(\frac{2\pi}{360^o}\right) = \frac{\pi R \Delta}{180^o}$$

Example: The design engineer has established a horizontal curve with a 550 foot radius be fit on a particular road. The surveyor measured a deflection angle of 37° 45' 30" at station 13+494.803 located at the PI. What are the other elements of the curve?

Solution: The tangent distance is found to be

$$T = 550.000 \ \tan\left(\frac{37^o 45' 30''}{2}\right) = 188.084 \ ft$$

The long chord becomes

$$LC = 2(550.000) \ \sin\left(\frac{37^o 45' 30''}{2}\right) = 355.931 \ ft$$

Compute the length of the curve.

$$L = \frac{\pi \ (550.000) \ 37^o 45' 30''}{180^o} = 362.454 \ ft$$

This value should make some intuitive sense in that the value for the length of the curve is longer than the chord distance. Next, the external distance is calculated as

$$E = 550.000\left(\frac{1}{\cos \frac{37^o 45' 30''}{2}} - 1\right) = 31.271 \ ft$$

The stationing for the PC is found by subtracting the tangent from the stationing for the PI.

$$STA_{PC} = STA_{PI} - T = (13+494.803) - 188.084 = 13+306.719$$

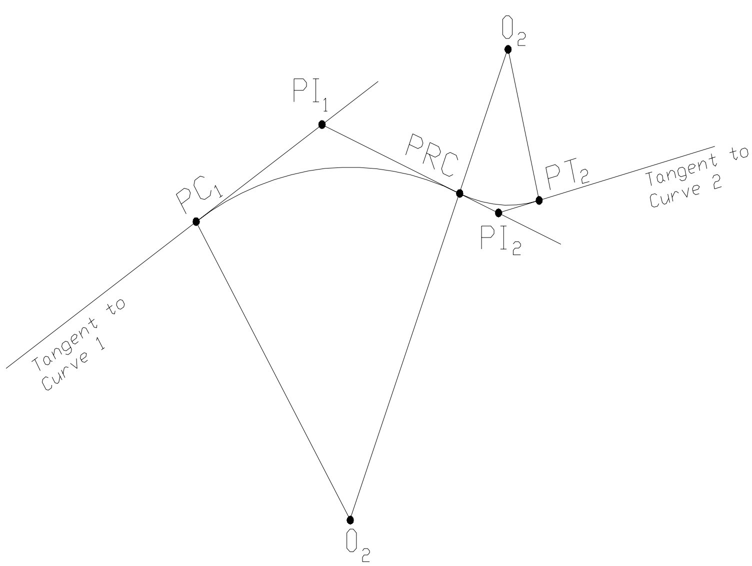
The stationing of the PT is computed by adding the arc length to the stationing of the PC.

$$STA_{PT} = STA_{PC} + L = (13+306.719) + 362.454 = 13+669.173$$

8.2.1.2 Reversed Curves

Reversed curves exist where there are two changes in direction, with the second change going in the opposite direction. In other words, two curves are attached to each other and the centers of the curves are on opposite sides of the proposed route of travel. There are basically two different ways in which the reverse curve can be constructed: parallel and non-parallel tangents. This latter case is shown in figure 8.3. The solution to this particular set of curves depends upon what values are given. Generally, the problem can be approached as two different curves that happen to be attached. The PRC is the point of reversed curve. It represents the PT for the first curve and the PC for the second curve.

Figure 8.3.
Reverse curve with non-parallel tangents.



The second geometric situation occurs when the tangents are parallel to each other. This is shown in figure 8.4. In this case, the central angles for both curves are the same ($\Delta_1 = \Delta_2 = \Delta$). This makes the calculations much easier to perform. Again, the curve elements can be solved for individually. The distance from **A** to **B** can be found using the following relationship:

$$AB = R_1 \sin\Delta + R_2 \sin\Delta = (R_1 + R_2) \sin\Delta$$

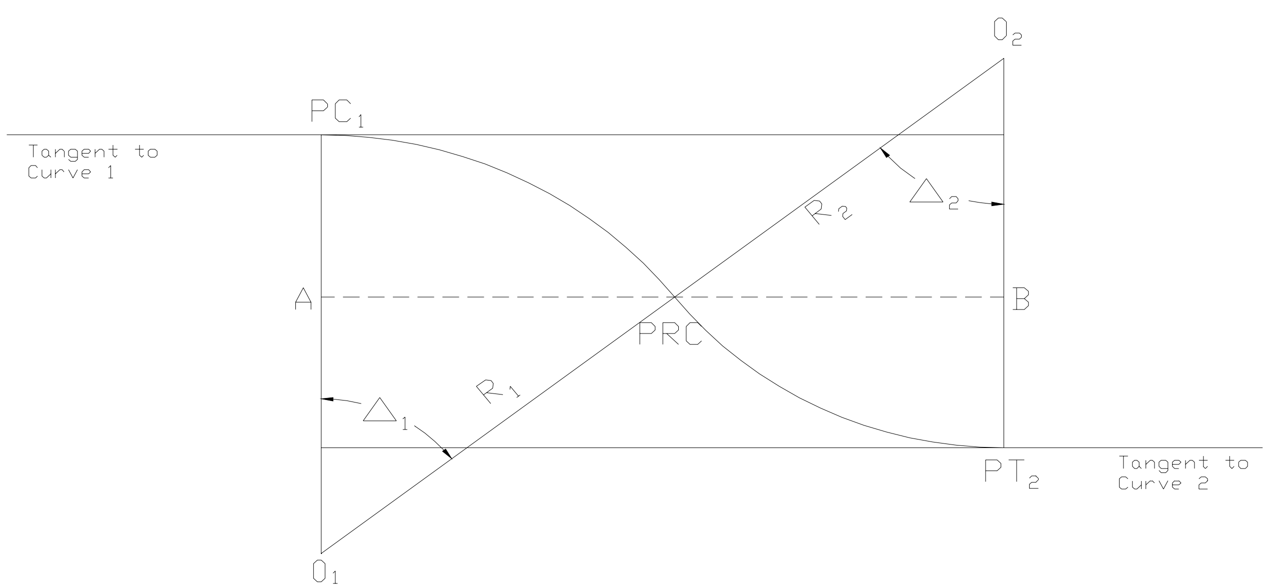
The offset distance between the two parallel tangents (distance PC_1 to A plus distance from B to PT_2) which can be designated as "p" can be computed using the following formula.

$$p = (R_1 + R_2)(1 - \cos\Delta)$$

The individual curve elements can be solved for as individual curve elements. If the radii of the two curves are equal, then

$$AB = 2R\sin\Delta$$

Figure 8.4
Reverse curve with parallel tangents.



and

$$p = 2R(1 - \cos\Delta)$$

8.2.1.3 Compound Curves

The compound curve is shown in figure 8.5. It consists of two horizontal curves with the center of the second curve lying on one of the radius lines of the first curve. Multiple curves can be attached in this manner. The PCC is the point of compound curve. This represents the PT of the first curve and the PC of the second curve. The deflection angle at V is the sum of the two central angles of the two curves. For construction purposes, point **A** is set so that there is a 90º from the tangent to the first curve to a line connected to the point of tangency of the second curve. The simplest approach

$$PC_1A = X = R_2 \sin\Delta + (R_1 - R_2)\sin\Delta_1$$

to solving for elements of the compound curve is to treat the geometry as a closed traverse involving points O_1, PC_1, A, PT_2, and O_2. The distance from PC_1 to A, designated as X, can be found from while the distance from A to PT_2, designated as Y, is computed using the next formula

$$APT_2 = Y = R_1 - R_2\cos\Delta - (R_1 - R_2)\cos\Delta_1$$

Figure 8.5
Geometry of the compound curve.

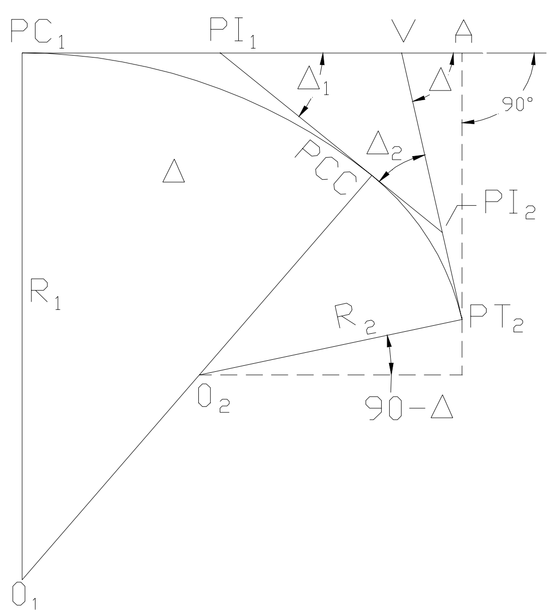
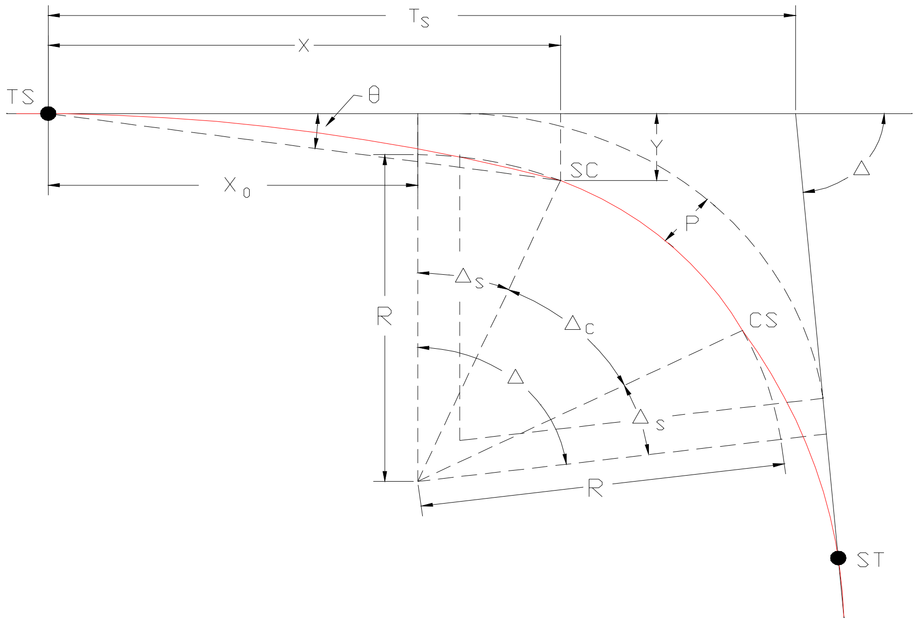


Figure 8.6
Geometry of the spiral.



The use of reverse and compound curves in high-speed transportation systems is not recommended since it is very difficult to incorporate a smooth transition curve with superelevation.

8.2.1.4 Spirals and Superelevation

On high-speed highways, the vehicle velocity will result in a centrifugal force when traveling through a curve. To compensate for this effect, the road design engineer will elevate or bank the outside edge of the road surface with respect to the inside surface. This is called superelevation. Both superelevation and the friction between the wheels and the road surface are used to determine how much banking should be applied to the road surface. Without this superelevation, a vehicle that is traveling too fast will either overturn or skid off the road. AASHTO has developed a relationship for the computation of superelevation shown as:

where: e = superelevation in meters/meter

f = side-friction factor

V = velocity of the vehicle in km/hr

R = radius of the curve, meters

$$e + f = \frac{V^2}{15R}$$

AASHTO has guidelines for the desired radius for a given superelevation and side-friction factor. Since the superelevation cannot be introduced directly into the curve at its beginning, a transition curve, called a spiral, is introduced between the tangent and the beginning of the curve. The superelevation is introduced by rotating the elevations of the pavement about the centerline of the roadway.

The spiral is shown in figure 8.6. The elements of the spiral are as listed as:

TS = tangent to spiral

ST = spiral to tangent

SC = spiral to curve

CS = curve to spiral

P = distance offset of curve from the tangent lines for the total spiral

R = radius of the curve

Δ = deflection angle or total central angle of spiral and curve

Δ_C = central angle of curve

Δ_S = central angle of spiral

θ = spiral deflection angle

X = distance from the TS to a point on the tangent that is perpendicular to SC

Y = offset distance from the SC to the back tangent

X_O = distance from TS to where the curve at radius R + P would intersect the tangent

The various elements of the spiral are usually found using spiral tables. The field and computational procedures usually involve:

- Measuring the deflection angle in the field
- Developing a design value for the radius of the curve which is based on the design speed
- Establishing the stationing of the point of intersection of the two tangents to the spiral
- Find the length of the spiral, L_S
- Compute the spiral angle and deflection angle of the spiral to locate the position of SC
- Compute the elements of the curve to stake its position in the field.

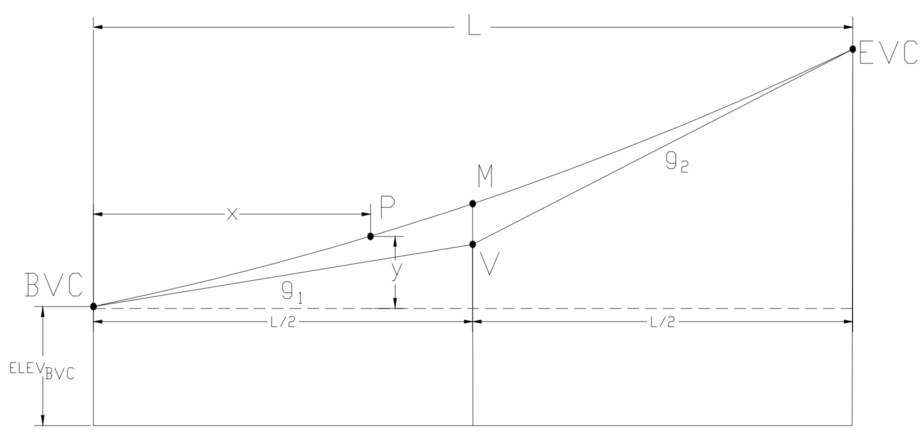
8.2.2 Vertical Curves

Another important safety concern is vertical line of sight between vehicles. Establishing vertical curves is necessary to ensure proper sight distance at a given design speed while fitting the road surface to the existing terrain without a lot of radical cuts and fills.

8.2.2.1 By Equation of the Parabola

The geometry of the parabola and the basis of the solution by the equation of the parabola is given in figure 8.7. The BVC represents the beginning of the vertical curve while the EVC is the end of the vertical curve. The total distance is designated by L while M is the mid point on the curve. The vertex of the two tangents is V. The BVC has an elevation above the datum. The tangent lines have grades of g_1 and g_2. If the signs of the two grade lines are different then there is a high/low spot on

Figure 8.7
Geometry of the vertical curve



the vertical curve. A point P on the curve has a station value designated by x and a difference in height, y, with respect to the BVC. The elevation of a point on the curve is found using the following relationship:

$$y = \left(\frac{r}{2}\right) x^2 + g_1 x + ELEV_{BVC}$$

where

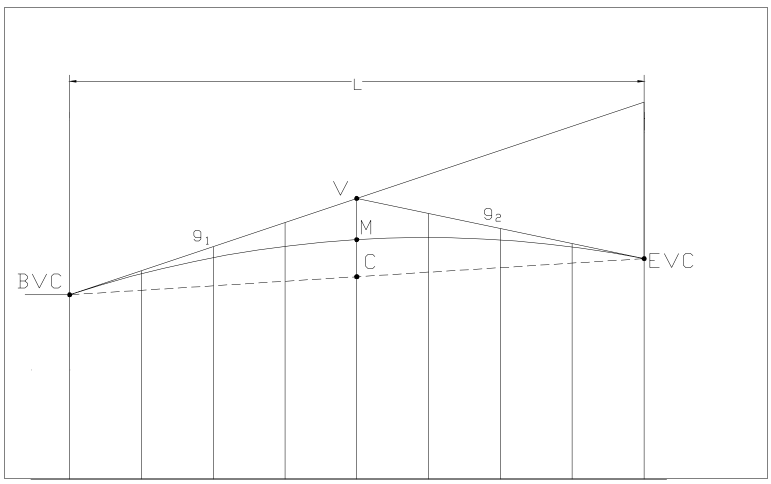
$$r = \frac{g_2 - g_1}{L}$$

8.2.2.2 By Vertical Offsets from the Grade Line

Another method of solving for the vertical curve is by offset distances from the tangent grade line. This method is visually depicted in figure 8.8.

Figure 8.8.

Vertical Curve by Tangent Offset.



The computation of the elevation of a point on the curve is performed using the following relationship.

$$y' = \left(\frac{x^2}{(L/2)^2} \right) d_{VM}$$

Where d_{VM} is the distance from the chord midpoint to the vertex of the vertical curve. It is computed using

$$d_{VM} = - \frac{ELEV_V - ELEV_C}{2}$$

The final elevation is found by adding y’ to the grade along the tangent at that station.

8.3 Terrain Data

8.3.1 Topographic Features

All topographic features on a particular site will be located. This includes man-made and natural terrain features that the surveyor will come across. Elevation data will be obtained as needed for project design, quantity computations and drainage studies.

8.3.2 Digital Terrain Modeling

A digital terrain model is a collection of elevations over a site which represents the characteristics of the terrain or ground. There are numerous data collection techniques that the surveyor can use. The most common systematic method of data collection is on a grid where elevations are obtained at grid nodes over the site. The advantage is the ease in data collection and data storage. The disadvantage is that important terrain points may not occur at the grid nodes and will be missed in the data collection. Therefore, these important points, called break lines, must be located and the elevations measured.

With total stations, data are normally collected in a random mode. The instrument will record all of the requisite data for subsequent processing. It is important that all critical terrain features be measured and to a sufficient density so that the software will properly portray the terrain features within the program. It is also necessary to observe a sufficient number of mass points that will aid in the processing of the digital terrain data.

8.3.3 Codes

Feature codes that will be used in data collection are listed on **at the end of this chapter.**

8.4 Specifications for Vertical and Horizontal Accuracy

Alignment points and intermediate traverse points have a standard of accuracy of 0.07 feet or below at the 95% confidence level.

As a general rule, for terrain elevations there should not be more than 60 feet between random observations to obtain elevations. The accumulated standard error for ground elevations should be no greater than 0.1 foot. All hard surfaced roads, curbs and sidewalks and water surface elevations shall be recorded to the nearest 0.01 foot. The relative error between adjacent elevations shall have an accumulated standard error of no more than 0.02 foot for hard surface measurements. If the total station method is used, instrument heights and target heights must be measured to the nearest 0.01 foot and recorded. Sights must be taken to targets on prisms. Distances for measurements taken to determine hard surface elevations must not exceed 600 feet. No distances for any topographical data collection shall exceed 1200 feet.

8.5 Deliverables

Data required to be submitted for alignment (type of alignment established shall be noted on each item below):

Hard copy format data:

- Copies of all records, measurement data, and calculations used to determine the alignment shall be part of the survey notes.
- A detailed description of the alignment including a sketch, coordinates of the PBO, PI's, POE, distance and bearing to each PI, and complete curve data, with stationing, associated with each PI shall be included in the alignment section of the notes. All station equations and a reference to recorded stationing shall be shown.
- Coordinate and witness list for the horizontal alignment ties.

Digital format data:

- Coordinate and witness list for the horizontal alignment ties.

The **type of alignment and method used to establish it** must be clearly explained in the surveyor's project report.

FEATURE CODES

Feature (LINES)	Description	DTM (Y/N)
ABUT	BRIDGE ABUTMENT	Y
BB	BOTTOM OF BANK	Y
BC	BACK OF CURB	Y
BDR	BIT DRIVE	Y
BEAM	BEAM	N
BIKE	BIKEWAY/PATH	Y
BLD	BUILDING	Y
BLOT	BIT LOT	Y
BRL	BRUSH LINE	N
BRR	CONCRETE BARRIER	Y
CC	CURB CUT	Y
CDR	CONCRETE DRIVE	Y
CEM	CEMETERY	N
CLB	CENTER LINE (BRIDGE)	Y/N
CL	CENTER LINE (GENERIC)	Y
CLOT	CONCRETE LOT	Y
CLV	CULVERT (GENERIC)	N
CMP	CORR METAL PIPE	N
CP	TRAVERSE CTL LINE	N
CRK	CREEK CL	Y
CTV	CABLE TV (UG)	N
DAM	DAM	Y
DCH	DITCH CENTERLINE	Y
DECK	BRIDGE DECK	Y/N
DIKE	DIKE	Y
DLOT	DIRT LOT	Y
DRV	SURFACED DRIVE	Y
EB	EDGE OF BITUMINOUS	Y
EC	EDGE OF CONCRETE	Y
EG	EDGE OF GRAVEL	Y
ELO	ELEC LINE OVERHEAD	N
ELU	ELECTRIC LINE (UG)	N
EM	EDGE OF METAL	Y
EP	EDGE OF PAVEMENT	Y
EW	EDGE OF WATER	Y
EWL	EDGE WETLAND	Y
FNC	FENCE LINE	N
FOP	FIBER OPTIC CABLE	N
FTG	FOOTING	N
GAS	GAS LINE (NATURAL)	N
GDR	GRAVEL DRIVE	Y
GLOT	GRAVEL LOT	Y
GR	GUARDRAIL	N
GRG	GARAGE	Y
GUT	GUTTER FLOW LINE	Y
H20	(UG) WATERMAIN	N
HDG	HEDGE LINE	N
HSE	HOUSE	Y
HWAL	HEADWALL	Y
LAKE	LAKE	Y
LL	LANE LINE	Y

Feature (LINES)	Description	DTM (Y/N)
MISC	MISCELLANEOUS LINE	N
MRSH	MARSH LINE	Y
NOIS	NOISE BARRIER WALL	Y
OCHD	ORCHARD	N
OIL	PIPE LINE (OIL)	N
PATH	PATH	Y
PIER	PIER	N
POND	POND	Y
PLAT	PLAT BOUNDARY	N
PROP	PROPERTY LINE	N
PVT	SURFACED ROADS	Y
RBOT	RIVER BOTTOM	Y
RCP	RNFC CONCRETE PIPE	N
RDG	RIDGE/BREAK LINE	Y
REFL	REFERENCE LINE	N
RIP	RIPRAP	Y
RIV	RIVER CENTERLINE	Y
ROC	ROCK OUTCROPPING	Y
RR	RAILROAD TRACKS	Y
RTWL	RETAINING WALL	Y
SAN	SAN SEWER LINE	N
SCL	SURVEY CENTER LINE	Y
SHBL	SHRUB LINE	N
SHLD	SHOULDER	Y
SLAB	CONCRETE SLAB	Y
SNLI	SIGN/BILLBOARD	N
SPL	SPILLWAY	Y
SS	STORM SEWER LINE	Y
STM	STEAMLINE (UG)	N
STRM	STREAM CENTERLINE	Y
STR	STRUCTURE	Y/N
SW	SIDEWALK	Y
TB	TOP OF BANK	Y
TELO	TELEPHONE (OVHD)	N
TELU	TELEPHONE (UG)	N
TGRPH	TELEGRAPH (UG)	N
TREL	TREE LINE	N
TRL	TRAIL	Y
WEIR	WEIR	Y
WWAL	WING WALL	Y

Feature (POINTS)	Description	DTM (Y/N)
ALI	ALIGNMENT PT	Y
ANC	DEADMAN	Y
AZM	AZIMUTH MARK	N
BFR	BIG ROCK	Y
BSH	BUSH	Y
CB	CATCH BASIN	Y
CEM	CEMETERY	Y
CP	TRAVERSE POINT	N
CTRS	CENTER SECTION CORNER (PLS)	N
ELHH	ELEC HANDHOLE	Y
ELMH	ELEC MANHOLE	Y
ETB	ELEC TRANS BOX	N
FCOR	FENCE CORNER	Y
FL	FLOW LINE	Y
FLAG	FLAG POLE	Y
GFP	GAS FILLER PIPE	N
GLM	GASLINE MARKER	Y
GPMP	GAS PUMPS	N
GPS	GPS MONUMENT	N
GVLV	GAS VALVE	Y
GTU	GAS TANK (UNDGND)	Y
GWEL	GAS WELL	Y
GYP	GUY POLE	Y
GYW	GUY (DEADMAN)	Y
HI	HIGH POINTS	Y
HVCP	PHOTO TARGET	N
HYD	FIRE HYDRANT	N
LBASE	LIGHT BASE	N
LBOT	LAKE BOTTOM (PNT)	Y
LO	LOW POINTS	Y
LP	LIGHT POLE	Y
MB	MAILBOX	Y
MBOX	MONUMENT BOX	Y
MEAN	MEANDER COR (PLS)	N
MISC	MISC POINT	N
MH	MANHOLE	Y
NGS	NGS MONUMENT	N
NWLK	WALK-NOWALK SIGN	N
OWEL	OIL WELL	Y
PK	PK NAIL	Y
PH	TELEPHONE OR CALLBOX	Y
PIN	IRON PIN	N
PINE	CONIFER TREE	Y
PIPE	IRON PIPE	N
PLAT	PLAT CORNER	N
PLP	POWER LIGHT POLE	Y
POLE	UTILITY POLE (GENERIC)	Y
POST	POST (GENERIC)	Y
PP	POWER POLE	Y
PROP	PROPERTY CORNER	N
PTWR	POWER TOWER	Y
QCOR	QUARTER SECTION CORNER (PLS)	N

Feature (POINTS)	Description	DTM (Y/N)
QQCOR	SIXTEENTH CORNER (PLS)	N
RBOT	RIVER BOTTOM (PT)	Y
RFPT	REFERENCE PT	Y
RM	REFERENCE MARK	N
RRSG	RR SIGNAL	Y
RRSW	RR SWITCH BOX	Y
RW	ROW MARKER	Y
SMH	SANITARY MH	Y
SCOR	SECTION CORNER (PLS)	N
SD	SATTELITE DISH	N
SGN	SIGN POST	Y
SIG	TRAFFIC SIGNAL	Y
SPKHD	SPRINKLKER HEAD	Y
STA	SURVEY STATION	N
STMH	STORM MH	Y
STMP	STUMP	Y
TMH	TELEPHONE MH	Y
TP	TELEPHONE POLE	Y
TPED	TELEPHONE PED	Y
TR	TRAVERSE/TP POINT	N
TREE	DECIDUOUS TREE	Y
TSTHL	TEST HOLE	Y
UMH	UTIL MH (GENERIC)	Y
USGS	USGS MON	N
VCP	VERT TARGET	N
WELL	WELL (GENERIC)	Y
WIT	WITNESS SEC CORNER (PLS)	N
WSO	WATER SHUT-OFF	Y
WV	WATER VALVE IN MANHOLE	Y
WWEL	WATER WELL	Y
XYZ	RANDOM SHOT (SPOT ELEV)	Y

Note:

The following codes have been removed and are no longer used:

LINE CODES:

BS	BOTTOM OF SLOPE	
EBIT	EDGE OF BIT	
ED	EDGE(GENERIC)	
GPS	TRAVERSE LINE	
RCL	ROAD CL	
TOE	TOE OF SLOPE	
TRAV	TRAVERSE LINE	
TS	TOP OF SLOPE	

POINTS:

CNIF	CONIFEROUS TREE	
SBSE	SIGN BASE	
SPEL	SPOT ELEV	

NEW CODES HAVE BEEN ADDED AND ARE UNDERLINED IN THE ABOVE LIST.

SUGGESTIONS FOR ADDITIONAL CODES SHOULD BE SENT TO BRIAN DOLLMAN-JERSEY IN THE SENSING OFFICE